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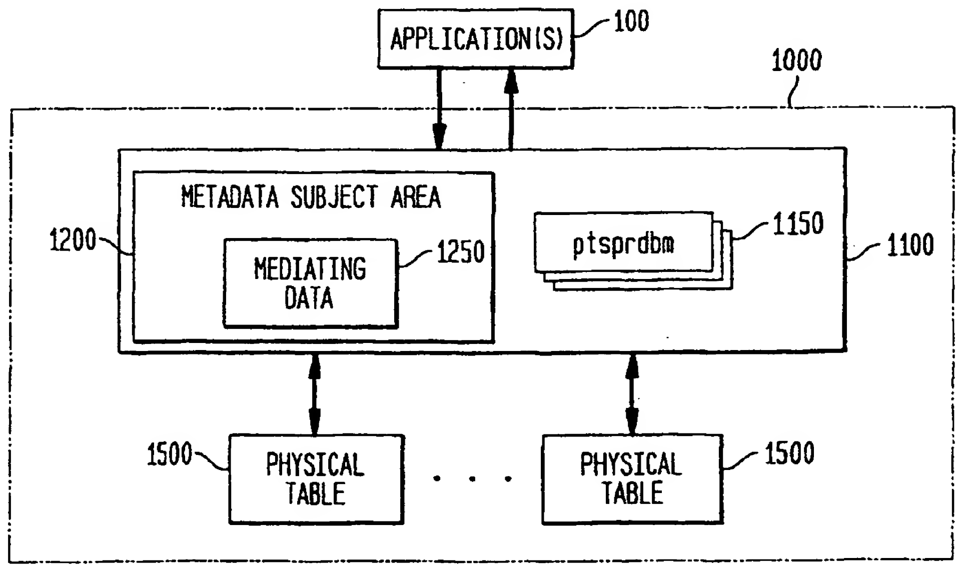
[Continued on next page]

(54) Title: METHOD AND APPARATUS FOR SUPPORTING DYNAMIC RUN-TIME OBJECT DEFINITION IN A RELATIONAL DATABASE MANAGEMENT SYSTEM



(57) Abstract: A method and system for providing dynamic run-time object definition in a relational database. A mediating layer is introduced between applications (100) and database objects. This layer mediates access to the physical database objects, such as tables (1500), and allows applications to embed logical instead of physical names. If desired, the mediating layer can be maintained dynamically, as applications are running. The mediating layer preferably can run on a variety of relational databases, overcoming the vendor-specific extensions to SQL that relational databases vendors have introduced.

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METHOD AND APPARATUS FOR SUPPORTING DYNAMIC RUN-TIME OBJECT DEFINITION IN A RELATIONAL DATABASE MANAGEMENT SYSTEM

Field Of The Invention

The present invention relates to database systems and methods.

Background Information

Applications that access a relational database reference objects in the database (tables, columns, etc.) by name. This creates a close coupling between applications and the database objects. This close coupling causes complications when upgrading either the database or the application. This situation is exacerbated when multiple applications may reference the same objects and those applications may themselves be upgraded at different times at an installed site.

A traditional solution to the aforementioned problem is to make use of the "view" construct typically provided by relational databases. The use of database view, however, is problematic due to the well-known deficiencies of updating views and because views often incorporate non-standard SQL syntax in their definitions. Being able to run on relational databases from different vendors is a desirable capability.

Summary Of The Invention

The present invention is directed to a method and apparatus that allows dynamic run-time object definition in a relational database.

In an exemplary embodiment of the present invention, a layer of data and processing is introduced between the application and the database object. This layer mediates access to the physical layer and allows the application to embed logical instead of physical names. The present invention also allows for the maintenance of this layer to happen dynamically, as applications are running, if desired. The mediating layer preferably can run on a variety of relational databases, overcoming the vendor-specific extensions to SQL that relational database vendors have introduced.

An exemplary embodiment of the present invention is implemented with the POEMS Data Exchange (a.k.a: "DEX") and the POEMS service processor "ptsprdbm" of Platinum Technology, Inc. The DEX stores the data used by the mediating layer and the processing is handled by the ptsprdbm service processor. In this embodiment, the DEX mediating layer can be seen as a mapping between messages submitted to the DEX and the physical table layout of the DEX. This mapping allows for multiple associations to physical tables, thereby insulating higher layers from changes to the physical implementation. Also, the mediation defines logical transactions which associate one or more application requests with an action to be performed on a table or set of tables.

In an exemplary embodiment, each application creates one or more requests which are sent to the DEX. For each request, the

DEX returns one result. There may be one or more ptsprdbm processes running. Each application request is handled by one ptsprdbm service processor process. The mediating layer data is stored in a metadata subject area of the DEX. All instances of ptsprdbm running on the same machine refer to the same metadata. The metadata maps requests from the applications to the physical tables. Consequently the applications do not need to know the identifiers of the physical tables. The physical tables may change over time and, provided that the metadata mapping is maintained, the applications will be insulated from these changes.

For example, a client may request data, through a message, about a logical entity called "machine". The logical name "machine" may or may not correspond to a physical table called "machine". It is the responsibility of the mediating layer to correctly translate logical transaction names to physical table names and columns.

In another example, a client may submit a message which is mapped to the logical transaction named "ip_address for machine" where "machine name" = absun10. In this example, the quoted elements should be considered logical objects which must be translated to physical objects. This is desirable since the requested data could change format as well. For example, in version 1 of POEMS, the physical database may store only one ip_address for each machine. In version 2 of POEMS, however, the database may store a list of ip_address for each machine. This would cause a different result set to be returned to the client, possibly breaking the client application. Using the mediating data, a new logical transaction is defined for version 2 which the service processor would know how to handle and the correct result set would be returned to the client.

An advantage of using a mediating data layer in accordance with the present invention is that applications can define new messages containing new logical transactions and have the DEX service processor correctly handle these new messages without modifications to the existing service processor. An application would simply add a row to the DEX metadata tables to define a new logical transaction. The service processor would know to map the new message to the logical transaction data added to the metadata tables and would consequently construct the correct SQL command for the new message.

Changes to the physical database can be handled in a similar way. A new logical transaction would be defined mapping an old message to a new table layout. This could be done either by using a version number with each transaction or by deleting the original transaction from the metadata.

The metadata could also be used to integrate tables created by the user into the DEX. The user would create a table using standard SQL, then would add rows to the DEX metadata tables to describe the new table. The user could also create per_triggers so that the new table could be automatically updated when an existing table is updated.

Brief Description Of The Drawings

FIG. 1 is a block diagram of an exemplary system in accordance with the present invention.

FIG. 2 is a flow-chart of an exemplary process in accordance with the present invention.

Detailed Description

FIG. 1 is a block diagram of an exemplary embodiment of a system in accordance with the present invention which is implemented with a POEMS data exchange (DEX) 1000. The POEMS DEX is described in the PLATINUM ProVision Common Services Reference Guide. The DEX 1000 comprises a plurality of physical tables 1500 and can interact with one or more applications 100. Examples of applications 100 include ProVision Director and TS Reorg.

In accordance with the present invention, a mediating layer 1100 is provided between the applications 100 and the physical tables 1500 of the DEX 1000. The mediating layer 1100 includes one or more instances of a POEMS relational database service processor (ptsprdbm) process 1150 and a metadata subject area 1200. Mediating data 1250 is stored in the metadata subject area 1200. The mediating data 1250 is used by the ptsprdbm service processor 1150 as described below.

The mediating layer 1100 provides a mapping between messages submitted to the DEX 1000 and the physical table layout of the DEX. This mapping allows for multiple associations to physical tables thereby insulating higher layers from changes to the physical implementation. Multiple logical names can refer to the same physical object and the logical names may change over time. Also, the mediation defines logical transactions which associate one or more application requests (e.g., PEC messages) with an action to be performed on a table or set of tables. An action corresponds to one of the data manipulation language (DML) verbs: insert, update, select, delete.

Each application 100 creates one or more requests and sends the requests to the DEX 1000. The DEX 1000 returns a result for each request received. One or more ptsprdbm service processor processes 1150 may be running at any one time. Each application request is handled by one ptsprdbm process 1150. All instances of ptsprdbm running on the same machine refer to the same metadata. There are one or more physical tables. The metadata maps requests from the applications to requests to the physical tables. Consequently the applications 100 do not need to know the identifiers of the physical tables 1500. The physical tables 1500 may change over time and, provided that the metadata mapping is maintained, the applications will be insulated from these changes.

The mediating metadata 1250 can be updated, for example, by updating POEMS or by updating an application 100. For example, a new application 100 can have new mediating data relevant to that application placed into the metadata subject area 1200. This capability provides flexibility in that the various products which use the system of the present invention can evolve separately, without requiring all applications to be updated at the same time. Preferably, such updates are carried out by the service processor 1150, as opposed to providing applications 100 direct access to the mediating metadata 1250.

Translations occur in the DEX service processor 1150. The service processor 1150 uses the mediating data 1250 to perform the translation. The service processor 1150 preferably uses a standard, open interface such as open database connectivity (ODBC) to interface with the metadata subject area 1200 and/or the applications 100.

In an alternative embodiment, a custom POEMS ODBC driver encapsulates the translation layer of the service processor 1150. This driver could then be used by third party applications for accessing the DEX (e.g. InfoReports).

In an exemplary embodiment, the mediating data 1250 comprises a set of tables as follows:

per_table:	This table includes the master list of tables. Each table in the DEX will have an entry in this table.
per_column:	This table contains an entry for each column of each table in the DEX. Attributes associated with each column are type, size and position of the column within a table.
per_data_type:	This table includes a master list of all supported data types.
per_key:	This table contains attributes for building primary and foreign keys on DEX tables.
per_logical_object:	This table identifies a logical transaction and is used to lookup the transaction details as well as any triggers associated with the transaction.
per_tran_column:	This table identifies the columns belonging to a logical transaction and whether or not the column participates in

	the construction of the SQL "where" clause.
per_trigger:	This table associates a trigger with one or more logical transactions.

An exemplary schema for storing the mediating data 1250 as metadata is as follows:

```
CREATE TABLE per_source (
        per_source_id           int NOT NULL,
        source_description      varchar(255) NULL,
        product_id              int NULL,
        per_source              int NULL,
        per_last_updated        smalldatetime NOT NULL,
        per_status              smallint NULL,
        CONSTRAINT XPKper_source
                PRIMARY KEY (per_source_id)
)


CREATE TABLE per_tran_col_type (
        column_type             smallint NOT NULL,
        column_type_desc        varchar(31) NOT NULL,
        per_source              int NULL,
        per_last_updated        smalldatetime NOT NULL,
        per_status              smallint NULL,
        CONSTRAINT XPKper_tran_col_type
                PRIMARY KEY (column_type)
)

CREATE TABLE per_logical_object (
        object_id               int NOT NULL,
        object_name             varchar(30) NOT NULL,
        per_source              int NULL,
        per_last_updated        smalldatetime NOT NULL,
        per_status              smallint NULL,
        CONSTRAINT XPKper_logical_object
```

```
                PRIMARY KEY (object_id)
)

CREATE TABLE per_table (
        table_name              varchar(30) NOT NULL,
        storage_type            char(10) NULL,
        subject_area            CHAR(18) NULL,
        delete_policy           CHAR(18) NULL,
        sequence_nbr            numeric(10,0) NOT NULL,
        per_source              int NULL,
        per_last_updated        smalldatetime NOT NULL,
        per_status               smallint NULL,
        CONSTRAINT XPKper_table
                PRIMARY KEY (table_name)
)


CREATE TABLE per_key (
        table_name              varchar(30) NOT NULL,
        key_id                  smallint NOT NULL,
        key_type                char(1) NOT NULL,
        foreign_table           varchar(30) NOT NULL,
        per_source              int NULL,
        per_last_updated        smalldatetime NOT NULL,
        per_status              smallint NULL,
        CONSTRAINT XPKper_key
                PRIMARY KEY (table_name, key_id)
)


CREATE TABLE per_data_type (
        data_type               smallint NOT NULL,
        data_type_desc          varchar(31) NOT NULL,
        per_source              int NULL,
        per_last_updated        smalldatetime NOT NULL,
        per_status              smallint NULL,
        CONSTRAINT XPKper_data_type
                PRIMARY KEY (data_type)
)


CREATE TABLE per_column (
        column_name             varchar(30) NOT NULL,
        table_name               char(18) NULL,
        table_sequence          smallint NOT NULL,
        column_size             int NOT NULL,
        null_flag               smallint NOT NULL,
        sequence_flag           smallint NOT NULL,
        per_source              int NULL,
        per_last_updated        smalldatetime NOT NULL,
        per_status           smallint NULL,
        CONSTRAINT XPKper_column
                PRIMARY KEY (column_name, table_name)
)


CREATE TABLE per_key_column (
        column_name             varchar(30) NOT NULL,
        table_name              varchar(30) NOT NULL,
        table_name              varchar(30) NOT NULL,
        key_id                  smallint NOT NULL,
        per_source              int NULL,
        per_last_updated        smalldatetime NOT NULL,
        per_status              smallint NULL,
        CONSTRAINT XPKper_key_column
                PRIMARY KEY (column_name, table_name, table_name,
                key_id)
)


CREATE TABLE per_tran_type (
        tran_type               smallint NOT NULL,
        tran_type_name          varchar(31) NOT NULL,
        per_source              int NULL,
        per_last_updated        smalldatetime NOT NULL,
        per_status               smallint NULL,
        CONSTRAINT XPKper_tran_type
                PRIMARY KEY (tran_type)
)


CREATE TABLE per_tran (
        object_id               int NOT NULL,
        tran_type               smallint NOT NULL,
        tran_version            char(10) NOT NULL,
        per_source              int NULL,
        per_last_updated        smalldatetime NOT NULL,
        per_status              smallint NULL,
        CONSTRAINT XPKper_logical_tra
               PRIMARY KEY (object_id, tran_type)
)


CREATE TABLE per_trigger (
        object_id               int NOT NULL,
        tran_type               smallint NOT NULL,
        trigger_sequence        smallint NOT NULL,
        trigger_obj_name        varchar(30) NOT NULL,
        trigger_tran_type       smallint NULL,
        per_source              int NULL,
        per_last_updated        smalldatetime NOT NULL,
        per_status               smallint NULL,
        CONSTRAINT XPKper_trigger_det
               PRIMARY KEY (object_id, tran_type, trigger_sequence)
)


CREATE TABLE per_logical_column (
        object_id               int NOT NULL,
        logical_col_id          smallint NOT NULL,
        logical_col_name        varchar(30) NOT NULL,
        column_name             varchar(30) NOT NULL,
        table_name              varchar(30) NOT NULL,
        per_source              int NULL,
        per_last_updated        smalldatetime NOT NULL,
        per_status               smallint NULL,
        CONSTRAINT XPKper_logical_col
               PRIMARY KEY (object_id, logical_col_id)
)


CREATE TABLE per_tran_column (
        object_id               int NOT NULL,
        logical_col_id          smallint NOT NULL,
        tran_type               smallint NOT NULL,
        column_type             smallint NOT NULL,
        join_column             varchar(30) NULL,
        join_table              varchar(30) NULL,
        where_flag              smallint NOT NULL,
        order_by_sequence       smallint NOT NULL,
        group_by_sequence       smallint NOT NULL,
        sub_tran                varchar(30) NULL,
        per_source              int NULL,
        per_last_updated        smalldatetime NOT NULL,
        per_status               smallint NULL,
        CONSTRAINT XPKper_trans_detai
               PRIMARY KEY (object_id, logical_col_id, tran_type)
)


CREATE TABLE per_index_type (
        index_type              smallint NOT NULL,
        index_type_desc         char(20) NOT NULL,
        per_source              int NULL,
        per_last_updated        smalldatetime NOT NULL,
        per_status              smallint NULL,
        CONSTRAINT XPKper_index_type
               PRIMARY KEY (index_type)
)


CREATE TABLE per_index (
        table_name              varchar(30) NOT NULL,
        index_sequence          smallint NOT NULL,
        index_type              smallint NULL,
        per_source              int NULL,
        per_last_updated        smalldatetime NOT NULL,
        per_status              smallint NULL,
        CONSTRAINT XPKper_index
               PRIMARY KEY (table_name, index_sequence)
)


CREATE TABLE per_index_column (
        column_sequence         smallint NOT NULL,
        table_name              varchar(30) NOT NULL,
        index_sequence          smallint NOT NULL,
        table_name              varchar(30) NOT NULL,
        column_name             varchar(30) NOT NULL,
        per_source              int NULL,
        per_last_updated        smalldatetime NOT NULL,
        per_status              smallint NULL,
        CONSTRAINT XPKper_index_colum
                PRIMARY KEY (column_sequence, table_name,
                index_sequence)
)


CREATE TABLE per_config (
        per_version             char(10) NOT NULL,
        sp_version              char(10) NOT NULL,
        doc_version             char(10) NOT NULL,
        install_date            smalldatetime NULL,
        per_source              int NULL,
        per_last_updated        smalldatetime NOT NULL,
        per_status              smallint NULL,
        CONSTRAINT XPKper_config
                PRIMARY KEY (per_version, sp_version, doc_version)
)


CREATE TABLE per_status (
        per_status_nbr          smallint NOT NULL,
        per_status_name         varchar(31) NOT NULL,
        per_source              int NULL,
        per_last_updated        smalldatetime NOT NULL,
        per_status              smallint NULL,
        CONSTRAINT XPKper_status
                PRIMARY KEY (per_status_nbr)
)
```

An exemplary method of operation of the service processor 1150 in accordance with the present invention is depicted in a flow-chart shown in FIG. 2.

As shown in FIG. 2, (an instance of) the service processor 1150 receives a request from an application 100 in step 2010. Such requests are encapsulated in a data structure--i.e., the request data structure or RDS--inside an application request. In step 2020, the service processor unpacks the application request and extracts the members of the RDS. The data members include identifiers which are used by the service processor in step 2030 to access the metadata stored in the DEX. In step 2040, the identifiers are processed against the metadata. More specifically, the service processor uses the metadata to de-reference and map the contents of the request to the metadata. This processing results in a translation of identifiers in the RDS into identifiers used in the physical tables 1500.

The result returned by the de-referencing procedure is a set of valid physical names for the current instance of the database. The service processor obtains the set of physical names in step 2050. The service processor then uses this data in step 2060 to construct an SQL statement which can be executed directly against the database. The service processor then executes the SQL statement in step 2070 and gathers the results from the processing of the SQL statement. The results of the execution of the SQL statement are remapped in step 2080 to the logical names in the RDS that was received in step 2010. The results are then returned in step 2090 to the application associated with the logical names that the application used when making the request. In this way, the application is entirely insulated from the physical database and the identifiers used therein.

In another embodiment of the present invention, additional metadata is stored about DEX data including information as to which entity is authoritative about the data (i.e., which application "owns" the data in the physical tables and which application can update or remove the data).

In a further exemplary embodiment, display and formatting information is stored for each logical object and used by an application for rendering the data accessed through the mediating layer on a monitor or in a report. Storing display and formatting information in the metadata allows applications that use such data to dynamically render the data returned to them.

What is claimed is:

1. A system for processing data in a database, the system comprising:

a mediating data storage; and

a processor, wherein the processor:

receives a request from an application to process data;

extracts a logical identifier from the received request;

translates the logical identifier into a physical identifier by obtaining the physical identifier from a mediating data storage using the logical identifier;

retrieves data stored in a physical table identified by the physical identifier;

processes the data retrieved to obtain a result; and

returns the result to the application using the logical identifier.

2. A method for processing actions in a database system, comprising the steps of:

receiving a request from an application to process data;

extracting a logical identifier from the received request;

translating the logical identifier into a physical identifier;

retrieving data stored in a physical table identified by the physical identifier;

processing the data retrieved to obtain a result; and

returning the result to the application using the logical identifier.

3. The method of claim 2, wherein the step of translating includes obtaining the physical identifier from a mediating data storage using the logical identifier.

4. The method of claim 3, wherein the mediating data is updated dynamically.

5. The method of claim 3, wherein the mediating data storage is contained in a metadata subject area of the database system.

FIG. 1

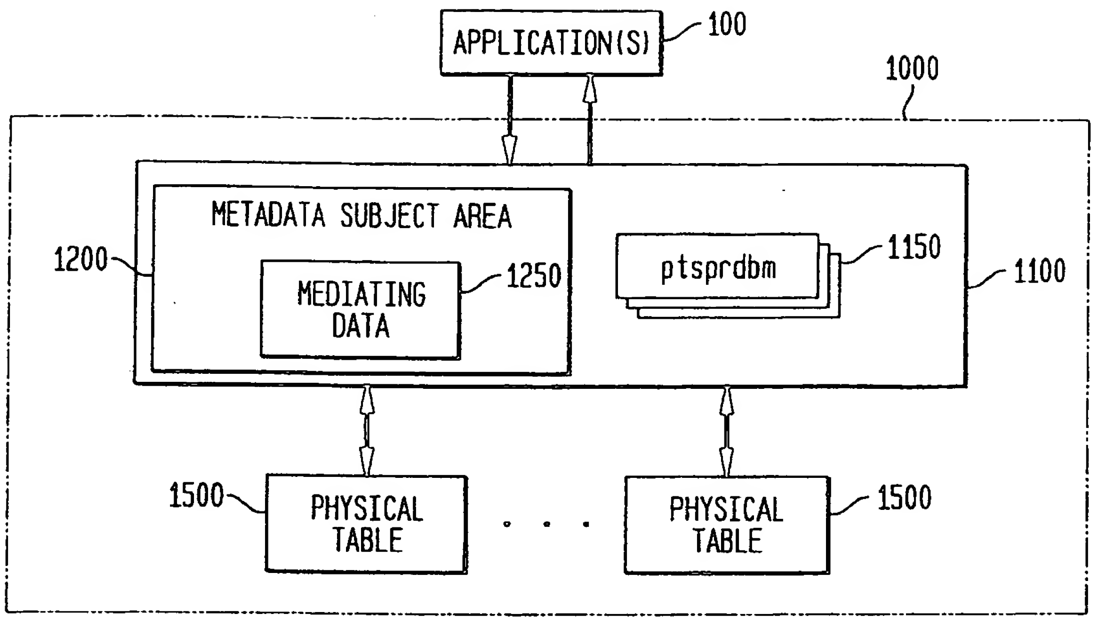
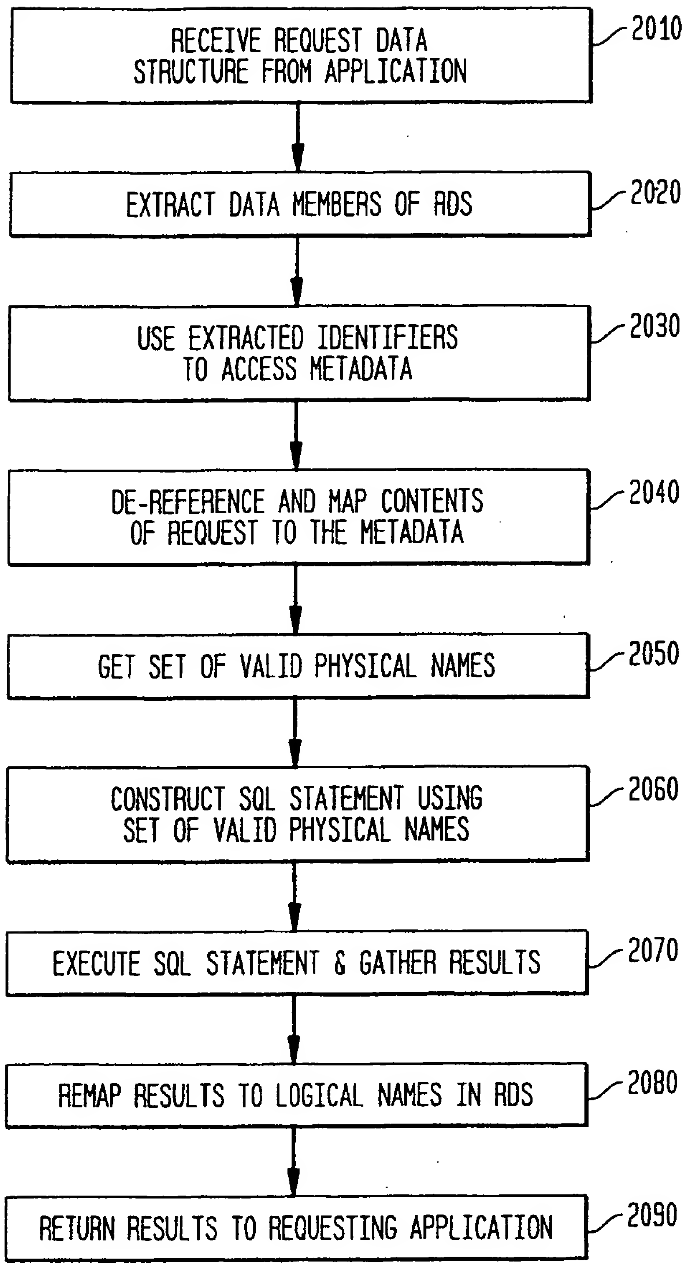

APPLICATION(S)
100
1000
METADATA SUBJECT AREA
1200
MEDIATING DATA
1250
ptsprdbm
1150
1100
1500
PHYSICAL TABLE
. . .
PHYSICAL TABLE
1500

FIG. 2


RECEIVE REQUEST DATA STRUCTURE FROM APPLICATION
2010
EXTRACT DATA MEMBERS OF RDS
2020
USE EXTRACTED IDENTIFIERS TO ACCESS METADATA
2030
DE-REFERENCE AND MAP CONTENTS OF REQUEST TO THE METADATA
2040
GET SET OF VALID PHYSICAL NAMES
2050
CONSTRUCT SQL STATEMENT USING SET OF VALID PHYSICAL NAMES
2060
EXECUTE SQL STATEMENT & GATHER RESULTS
2070
REMAP RESULTS TO LOGICAL NAMES IN RDS
2080
RETURN RESULTS TO REQUESTING APPLICATION
2090

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/28258

A. CLASSIFICATION OF SUBJECT MATTER
IPC(6) :G06F 17/30
US CL :707/3, 4, 100, 103
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 707/3, 4, 100, 103

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EAST, WEST

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,734,887 A (KINGBERG et al) 31 March 1998, column 29, lines 20-28; Figure 10; column 11, lines 16-25; column 17, lines 1-57.	1-5

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
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"P"	document published prior to the international filing date but later than the priority date claimed		

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06 FEBRUARY 2000

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